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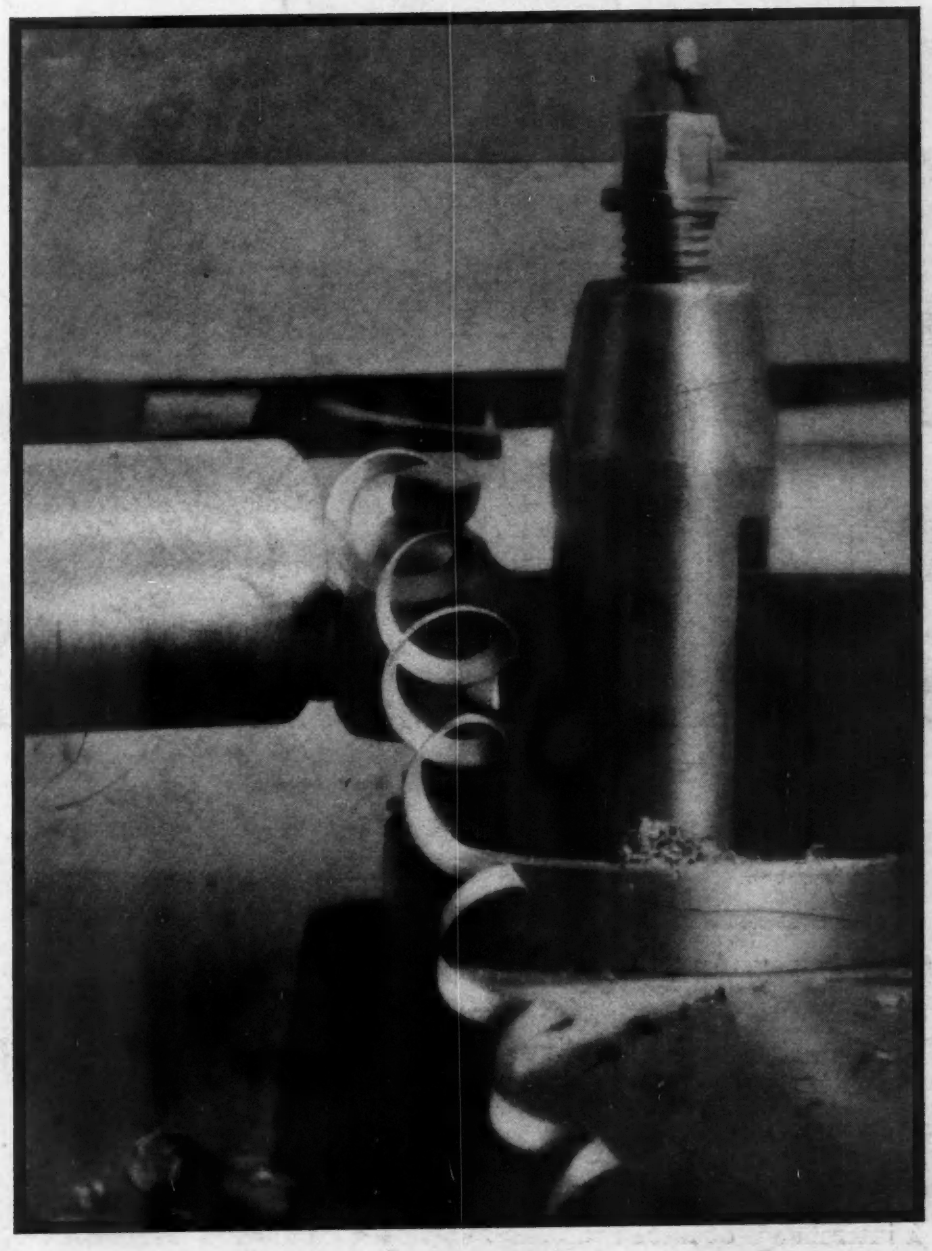

THE RUST RACKET

STACKS

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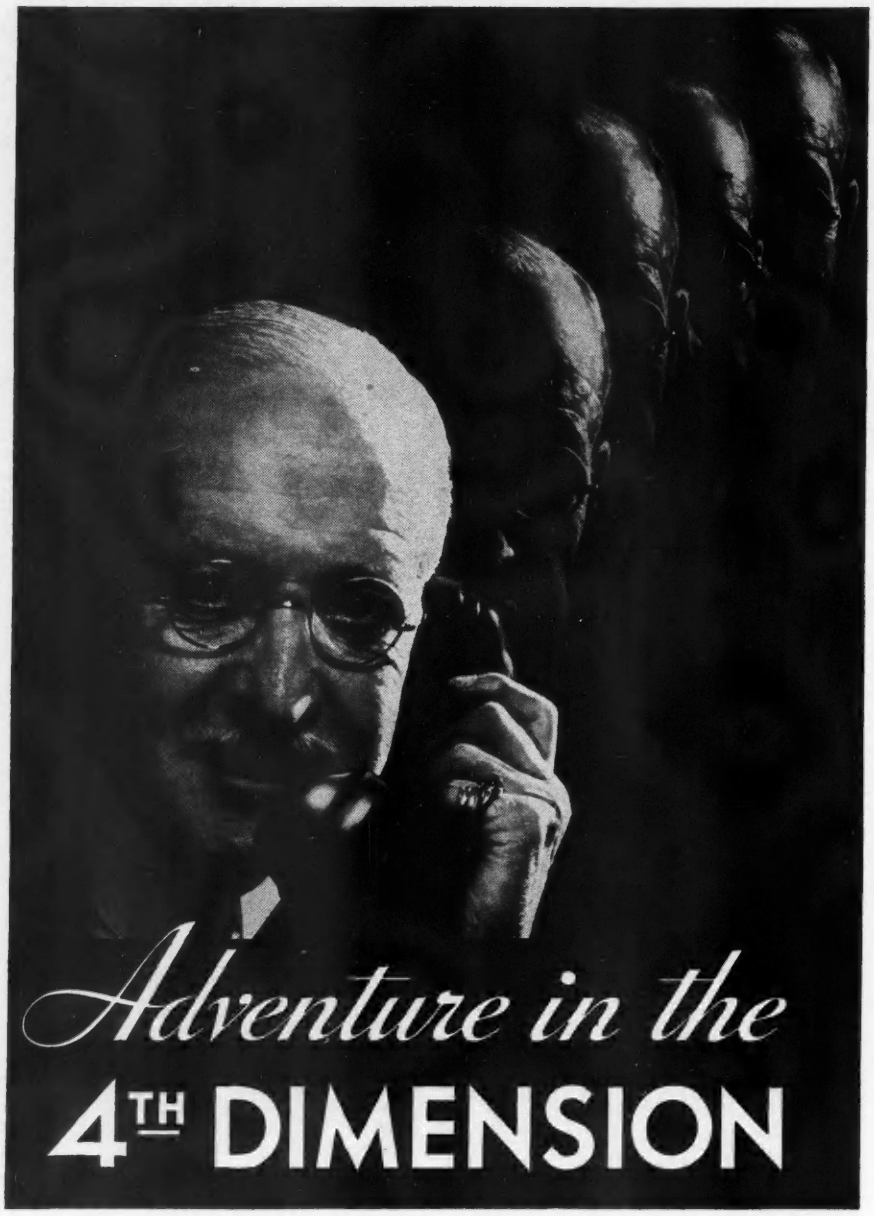

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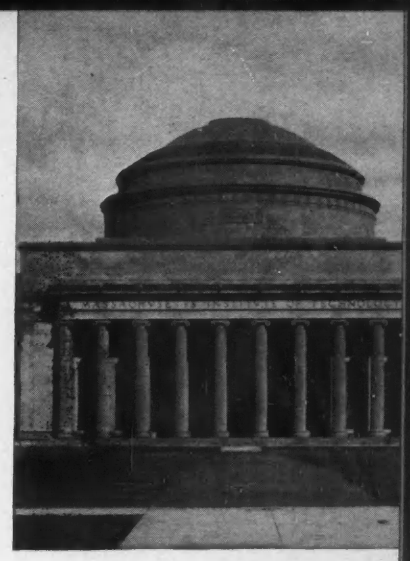

NOVEMBER, 1934
VOLUME XV
NUMBER 5

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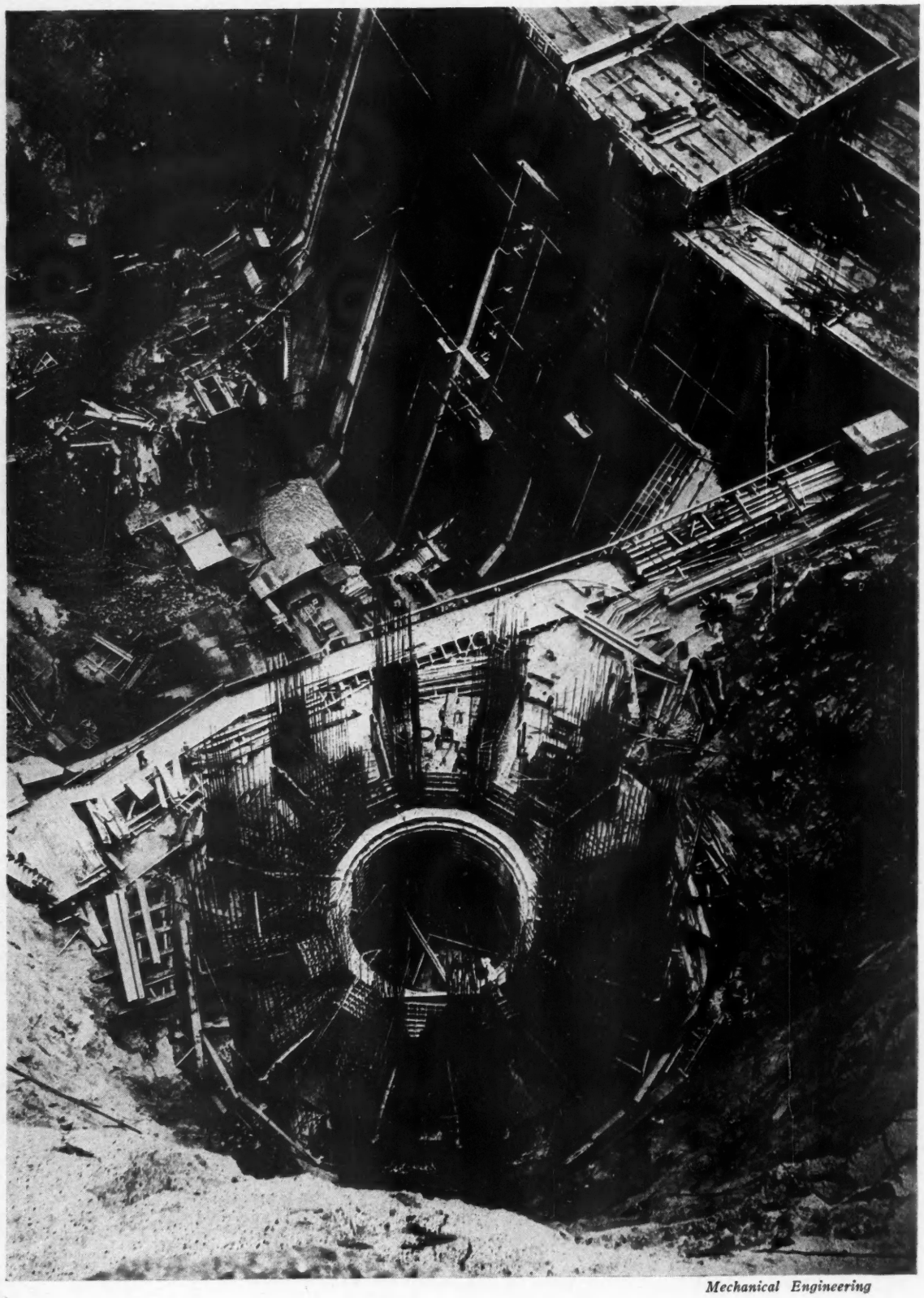
Published monthly throughout the school year, at Walker Memorial, Cambridge A, Massachusetts, by the undergraduates of the Massachusetts Institute of Technology for the purpose of disseminating news of scientific and industrial interest and of promoting closer co-operation between Alumni and undergraduates. Entered as second class matter, June 1, 1920, at the Post Office at Boston, Mass., under the Act of March 3, 1879. Acceptance for mailing at special rates of postage provided for in Section 1103, Act of October 3, 1917, authorized November 3, 1920. Copyright 1934 by The Tech Engineering News. Subscription per year $1.50. Foreign $1.75. Single copies 25 cents.



Mechanical Engineering

BIRTH OF A DAM

Defeating THE RUST RACKET *with Stainless Steel*

By C. C. SNYDER
Republic Steel Corporation

THE toll extracted from the public these days by various "rackets" is said to be tremendous. Much of it is paid out as a matter of course and without the realization that the racketeer is perhaps getting his percentage of tribute. The Federal Government is now actively engaged in the eradication of the racketeer, and the various local and state constabularies seem to be more earnest in their efforts to stamp out this evil.

The Rust Racket is a racket you probably have never heard mentioned and are familiar with its ramifications only in a general way, if at all. But if it were universally known that the Rust Racket exacts even greater tribute annually than all other rackets combined, certainly drastic steps would be taken to stop, or lessen, its maraudings.

No less an authority than Sir Robert A. Hadfield, famous British metallurgist, made the statement, before the Institution of Civil Engineers in 1922 that, "the loss by rust and corrosion of ferrous metals was probably no less than 700,000,000 pound sterling," which, even when translated into present day figures, is still a lot of money. This year in the *Times* of London, he suggested that, "the loss due to wastage in 1932 was about 67,000,000 tons," which amount is about 19,000,000 tons in excess of actual iron and steel production for that year.

Even the Justice Department of the United States Government or our own local police officers are of no help in stopping the foraging of the Rust Racket into our private and public treasuries. Within the past few years some steps have been taken which have retarded this racket somewhat, but it has been but a start and there is much work of an educational nature to be done before success can be assured.

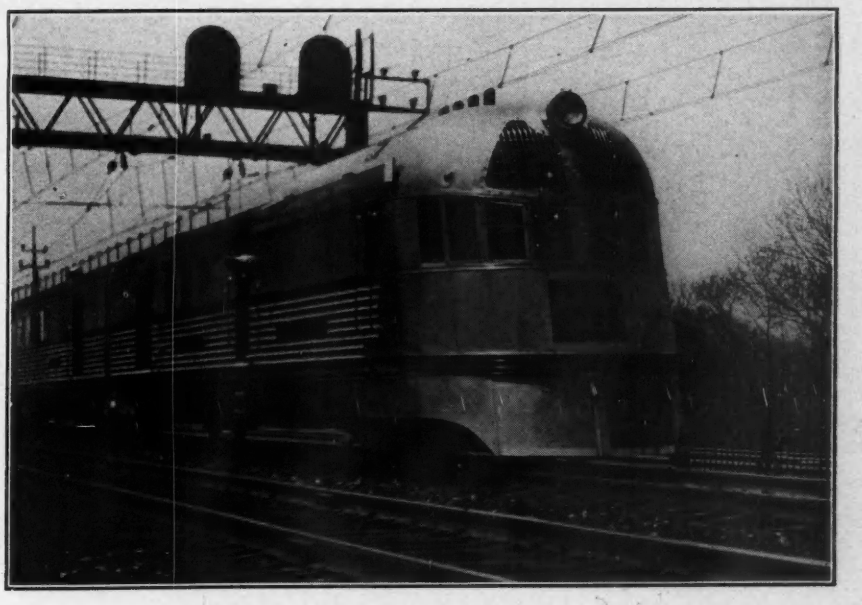
The members of the Rust Gang are the elements, the atmosphere, and such conspirators as sulphur laden smoke, salt water and salt air, and others which exact their toll to the extent of millions of dollars yearly in the form of rust and corrosion. This does not apply to the corrosion of iron and steel alone, but to other metals of a non-ferrous nature, as well.

Ever since products of iron and steel, and of the non-ferrous metals of aluminum, zinc, tin, copper, and silver, have been in use, we have known the effects of corrosion. In this country, at the present time, different gang leaders are in command. In New York City, air laden with sulphuric acid, together with the ordinarily corrosive salt air, are holding sway. At times their efforts are united, and again, not unlike typical gang leaders, they are battling each other for supremacy. In Pittsburgh, Cleveland, Chicago, and other steel centers, smoke and sulphur without the aid of salt air reign supreme. Along the sea shores, salt air and salt water are the "big shots" and collect their thousands of dollars every year in rusted and corroded equipment that must be rehabilitated or entirely replaced. Inland the absence of salt air eliminates this spectre, but its absence is more than balanced by the highly corrosive atmosphere typical of the industrial center and the more or less dampness of the climate.

Other than the inroads made by the aforementioned causes, we find in our own homes that the water pipes become rusted and leak or burst. The furnace pipe and furnace proper corrode, the hot water tank burns through, the house screens, unless made of a special metal, must be painted every year or so, or be replaced, the spouting and flashing is serviceable only for several years, the garden and lawn equipment, if left unprotected, rusts beyond repair, and the fenders of our automobiles rust through when unprotected with paint.

In industry the same thing is again encountered, but on an even larger scale. Some of the major industries most vitally concerned with the effects of the rust and corrosion racket are the meat packing industry, the dairy industry, the food and baking industries, the chemical industry, the textile and dyeing industry, the brewing and distilling industry, the automobile industry, the paper and pulp industry, the mining industry, and numerous other industries of lesser import.

Let us take, for example, the dairy industry, with which we are all to some extent familiar. The necessity for absolute cleanliness and sanitation in handling milk and its products is well recognized. The importance of milk products as foods and their highly perishable nature make necessary the greatest care in their preparation for the market. We do not think of milk as being of a cor-



The Burlington "Zephyr" a marvel of glittering beauty and swanky lines — stainless steel bullet-train.

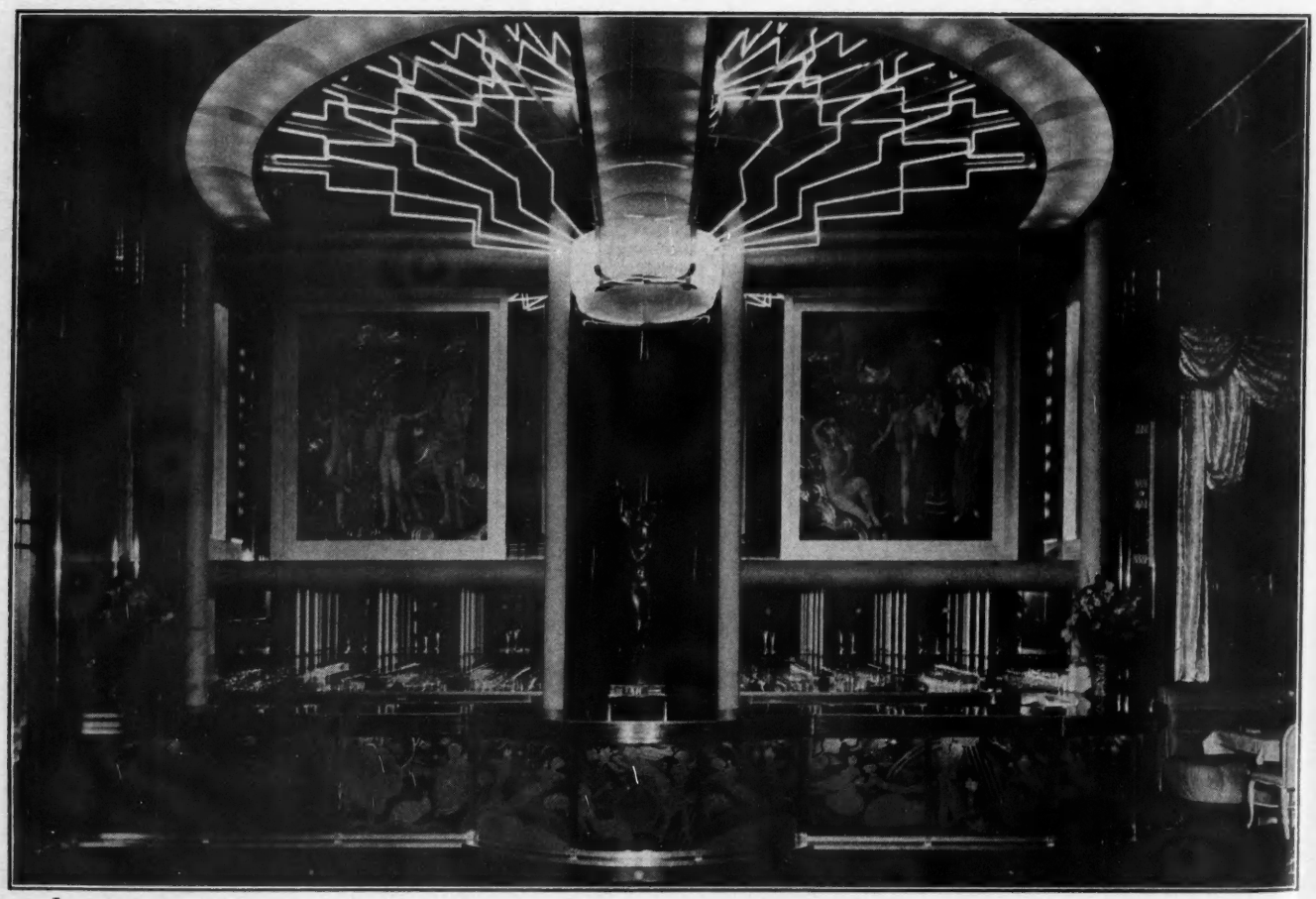
rosive nature, yet there are few metals which are entirely impervious to the action of lactic acid which is present in milk. Tin is a suitable metal from the standpoint of resistance to attack by dairy products, but it is attacked by refrigerating brines. Tin is soft, its mechanical properties are not very good, and it is expensive. To overcome these deficiencies, tin is used mainly in the form of plating on stronger and cheaper metals, such as steel or copper. The tinned milk pail and tinned milk can are common sights on the farm and along the country road. This type of tinned product is satisfactory so long as the plating remains continuous, but it is a condition which is difficult to maintain, and frequent retining is required. Experiments have shown that minute quantities of copper or steel introduced into milk, because of improper plating, cause rapid deterioration of flavor. This action takes place not only with pure copper, but also with rich copper alloys, such as Monel metal and German or nickel silver.

Nickel has been heralded as a substitute for tinned products and is satisfactory in many respects, although it is soluble in milk at the pasteurizing temperature and tarnishes under atmospheric conditions and in the presence of milk owing, no doubt, to the sulphur content of milk proteins. Pure nickel, too, is expensive. Glass lined steel tanks, in which the glass enamel has been fused into the steel at high temperature, are being used for pasteurizing tanks, holding and storage tanks, and truck tanks for transporting milk to the dairy. Like all coated or plated materials, equipment made with glass linings, is only serviceable as long as the lining remains efficient. Because glass is fragile and subject to breakage, its use has been somewhat retarded.

Stainless steel was introduced to the dairy industry in 1924. Its adoption was rather slow at first, such as is the case with any new product. The ensuing years, particularly from 1929 to the present time, have seen a large amount of it used. Now there is hardly a dairy of any consequence that is not fully equipped with stainless steel pasteurizers, holding tanks, coolers, truck tanks, and similar equipment. It has been proven both by laboratory experiments and by actual service, which in the end is the true criterion, that stainless steel of the chrome-nickel type is admirably well suited for dairy equipment. It is immune to the action of milk products, is without effect on color or flavor, and is unattacked by cleansing agents, sterilizers, or refrigerating brines. This type of alloy is likewise not affected by sulphur, whether present in milk proteins or in natural water as found in some localities.

A word now, regarding stainlness steel, which has been found to be the most resourceful opponent of the Rust Racket. In the first place, stainless steel is composed mainly of iron, to which has been added a certain amount of chromium and in most cases nickel, as well. Secondly, stainless steel as we know it is really not a steel, but an iron, and, in the third place, it is not always stainless. These statements all need qualifying and are made with reservations. The first statement that stainless steel is composed of iron, chromium, and nickel, is substantially correct, although it is true that certain other alloying elements are added to this base for special purposes, namely, molybdenum, tungsten, copper, titanium, selenium, and columbium.

The second statement, in which it is said that stainless steel is not a steel, but an iron, is true, with but few



The sparkle of stainless steel combines with glamorous colors and exquisite art panels to create an effect pleasing to the eye.

exceptions. A simple differentiation between iron and steel is this: when iron contains enough carbon so that it will harden appreciably when it is quenched from a high temperature, it is called steel; otherwise, it is known as iron. Applying this definition to stainless alloys, we find there are several types which can rightfully be called stainless steels, but the greater percentage are of the non-hardening type and are really stainless irons.

The third statement that stainless iron or steel is not always stainless is perhaps a drastic claim to make, and must not be construed as a condemnation of stainless iron. For most purposes stainless iron is stainless, non-tarnishable, and non-corrosive, but there are several notable exceptions which are of little concern to the general public. There are several strong inorganic acids, namely, sulphuric, muriatic (commercial name for hydrochloric acid), and hydrofluoric, which will corrode stainless steel. Often these acids are found in combination with other compounds, or in dilute solutions, which may or may not react on the corrosion resisting alloys. Definite statements cannot be made in all cases, and it is often a matter of testing and experimenting to determine what the result will be. With the exception of these three acids, however, stainless is resistant to all the other common acids. Nitric acid, just as powerful in its effect as sulphuric and muriatic acid, is manufactured, stored, and shipped in stainless steel equipment and containers. Neither ordinary atmosphere, salt atmosphere, or air contaminated with traces of sulphuric acid, have any effect on the 18-8 grade of stainless. Because of the fact that stainless iron or steel is not always stainless in the strict sense of the word, the name is really a misnomer, a more suitable term being corrosion resisting iron, or corrosion resisting alloy. The name "stainless steel," however, seems to be the popular designation and no doubt will continue to be, regardless of its propriety.

One illustration which is often pointed to as an outstanding example of the continual effort to stop the inroads of rust is the periodical painting of iron and steel bridge structures. The cost of such maintenance work runs into high figures annually, the brunt of which is borne by the taxpayer. And it is maintenance that is absolutely necessary to insure the safety of the public. If such structures were allowed to go unpainted for several years, they would be weakened to such an extent, by rust and corrosion, that they would be unsafe for heavy traffic. It would possibly be making a very broad statement, to say that the ideal material for bridge construction is stainless steel. It would increase the cost of construction perhaps five to tenfold and it is possible that stainless steel would not have some of the physical properties required for such structural work. If it so happened, however, that it did meet all the requirements for tensile and torsional strength and modulus of elasticity, we would have a structure, that within ten or fifteen years, would pay for itself in money saved through low maintenance costs. Further, it would be a structure that would endure for one hundred or even five hundred years, if not antedated before that time.

The salient feature of stainless iron is that it is not a plated metal—hence there is no plating to wear thin or chip, exposing a corrodible metal beneath. Because of its composition, it is inherently a relatively hard, tough metal and not subject to excessive wear. In spite of its hardness, which is approximately twice that of mild steel, stainless is a metal which can be readily fabricated into all sorts of commercial products.

A few years back one of our largest automobile manufacturers was confronted with the task of changing his

Music Hall entrances of shimmering stainless steel.

tarnishable nickel plated lamps and radiator shells to a more durable product. Other manufacturers had, just recent to that time, switched over to chromium plated parts. The chromium plated radiators and lamps were beautiful things to behold; that is, as long as the chromuim plate did not chip or peel off, exposing a corrodible metal beneath. But it did chip and peel, resulting in an unsightly appearance, and with much dissatisfaction to the owner and consternation to the manufacturer.

Stainless iron at that time was relatively new in this country (1928). It was being produced in large quantities by only two major companies, the Central Alloy Steel Corporation, now a part of Republic Steel Corporation, and Allegheny Steel Company. Its use was restricted primarily to chemical plant equipment, dairy equipment, food processing equipment, and cutlery.

The automobile builder, under discussion here, could follow the industry and equip his cars with lamps, radiators, and other bright parts of chromium plate, or there was the alternative of stainless steel, of which he knew very little. The possibility of using stainless steel, however, must have impressed him greatly, to be the first one to have lamp shells and radiators that would not corrode under any conditions—that would remain bright and shiny without any polishing as long as the car was in service. The decision was made in favor of stainless or "Rustless Steel," as the manufacturer still refers to it. It took courage on his part for it meant that ten thousand radiator shells and twenty thousand lamp shells must be made every day from this metal with which he had had no previous experience. It meant that new dies must be built and rebuilt until the stamping characteristics of the metal were learned. It meant the installation of thousands of dollars worth of polishing equipment to finish this new metal. It was pioneering, and pioneer-

(Continued on page 95)

MOUNTAINS OF SALT

—*Locating Petroleum Deposits*

By PAUL D. FOOTE and L. L. NETTLETON
Gulf Research & Development Corporation
Pittsburgh, Pa.

IN a territory less than one hundred miles wide and four hundred miles long, extending along the Gulf Coast from the Mississippi River in Louisiana southwest to the center of the coast line of Texas, at least 150 gigantic mountains of salt have been discovered. These mountains of sodium chloride are covered by depositional debris of a hundred million years; the present topography is a flat coastal plain so that the mountains are invisible. If the debris were removed, as illustrated in Fig. 1, the territory would present one of the great scenic attractions of the world. Huge pillars of salt from a mile to several miles in diameter, rising to heights of perhaps 20,000 feet, with smooth precipitous sides, would challenge the most skilled Alpine climber who dared to scale the top.

These buried mountains or "salt domes" are of great economic importance. A few, which have risen nearly to the present surface of the ground, are mined for table salt, but the principal value of the salt mountains is for the petroleum and sulfur deposits in the sand and rock formations surrounding the upper portion of the salt. The Gulf Coast of Texas and Louisiana produced about 75 million barrels of oil last year from fields which owe their existence to salt, and a large proportion of the world's supply of sulfur is derived from a few of the Gulf Coast domes.

Perhaps a hundred million years ago the region which is now the Gulf Coast of Texas and Louisiana was part of a shallow sea or bay intermittently cut off from the ocean by a low land barrier. The water from the ocean flowed into the area and was evaporated. This process was repeated during several million years until a salt accumulation of from 500 to 1000 feet in depth was laid down. Conditions changed. The area was submerged and normal sedimentation developed carrying down the remains of abundant marine fauna, the source of the present oil deposits. The old floor of the sea continually settled, perhaps under the weight of the depositional rock, and more debris accumulated until the original salt layer was buried fifteen to twenty thousand feet below the present surface of the ground.

Salt does not form a very hard or strong rock, and under the great pressure of the gradually increasing overburden, the salt began to behave like a liquid of exceedingly high viscosity. The density of salt is less than that of the surrounding rock so that there is a tendency for it to flow upward. Perhaps the original flow was started by an earthquake producing a weak spot or fracture in th earth's crust through which the salt was squeezed. The process necessarily required a vast amount of time; in some cases the flow undoubtedly was so slow that material was deposited at the surface faster than the salt was able to rise. In other cases the salt actually emerged, where it was subjected to heavy erosion by water. Some of the insoluble material present in the salt or carried up during the flow process remained on the top of the salt, forming a "cap rock" of limestone and anhydrite. On account of the later movements of the earth's crust the eroded salt mountain again became buried under several hundred feet of sand and shale. In some mysterious manner, free sulfur has occasionally been deposited in the porous limestone of the cap rock where today it forms the major source of our sulfur supply. The sulfur is not mined in the ordinary sense but is melted by injection of superheated water through drilled wells, and is air-lifted as a liquid to the surface.

As a dome gradually rises, it distorts the surrounding sediments, forming large traps in sand and limestone

(*Above and right*)

Fig. 2. Pendulum Crew. Plenty of science and exercise. The trucks are traveling laboratories. In spite of technical difficulties, this survey method has been successfully developed for field use.

that permit the accumulation of oil. Some of the porous rock formations are turned up steeply and pinched off against the dome. If such rocks become saturated with oil, we obtain an annular zone of oil accumulation so that the producing area is nearly a circular ring a mile or two in diameter and often only a few hundred feet wide. In other cases, especially where the present salt surface is very deep, the upper sand formations may be arched like an inverted bowl, forming an almost ideal trap for the accumulation of oil.

Occasionally the arching of the upper beds is sufficient to be perceptible at the surface. By 1924 some 40 domes had been discovered, the existence of many being indicated by traces in the present topography. Since then two general physical methods have been developed for the detection of domes where there is absolutely no visible evidence at the surface. One of these is based on gravity determinations, and the other involves the propagation of sound waves through the ground.

Fig. 1. If the depositional debris were removed from a strip of Gulf Coast territory, gigantic salt mountains would present one of the world's greatest scenic attractions. The higher peaks represented by salt dome models in the illustration rise twenty thousand feet above the base level.

Since the density of salt is less than that of the surrounding sediments, the effect of a large salt mass is to produce a gravity minimum at the surface of the earth. Two types of instrument are employed for the detection of gravity anomalies. By means of the torsion balance the gradient of gravity, *i.e.*, the direction and rate of change of gravity, can be measured. From these gradients, gravity differences may be computed and contours of equal gravity may be mapped. The balance measures rates of change of gravity as minute as one part in a million million (10^{12}) of gravity per horizontal centimeter. Gravity contours are commonly mapped with intervals as small as one or two parts in ten million of the normal gravity. The total variation in gravity over a good producing salt-dome oil field may be as small as two milligals, less than the difference in gravity between two stories of an office building.

A second method of gravity survey is by means of the pendulum. As it well known, the period of a pendulum varies (other things being constant) inversely with the square root of the value of gravity. The difficulty with the method as a prospecting tool is the fact that in order to detail a small gravity anomaly, of the magnitude described above, a precision of a very few parts in ten million is required, which places this type of work in the domain of the most precise physical measurements carried on in any research laboratory. In spite of the technical difficulties the method has been successfully developed for field use. Fig. 2 shows a photograph of a pendulum field crew and equipment in operation in the Gulf Coast.

Fig. 3 shows gradients and a gravity contour map of an area containing a salt dome. The dome appears as a pronounced gravity low due to the large mass of light salt, with a central gravity high due to the heavy cap rock. If a sufficiently detailed gravity survey is available, and if there exist a few geological data such as a contact point with the salt, it is possible to calculate the size and form of the salt mass which produces the gravity picture. Thus in Fig. 4, the gravity profile shown above, obtained directly from field observations, is produced by a salt dome of the size and shape indicated in the lower half of the figure. It is from calculations of this nature that most of our ideas regarding the magnitude of the buried salt mountains are obtained.

The second general method for exploring below the surface is by the use of the seismograph. The earlier

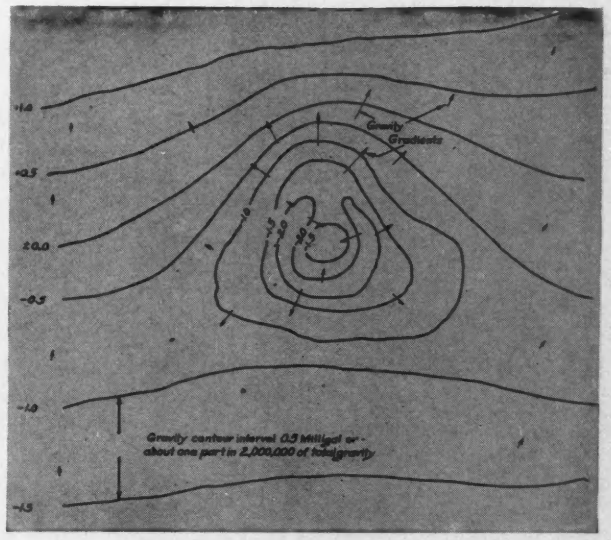


Fig. 3. Gravity contour map over salt dome.

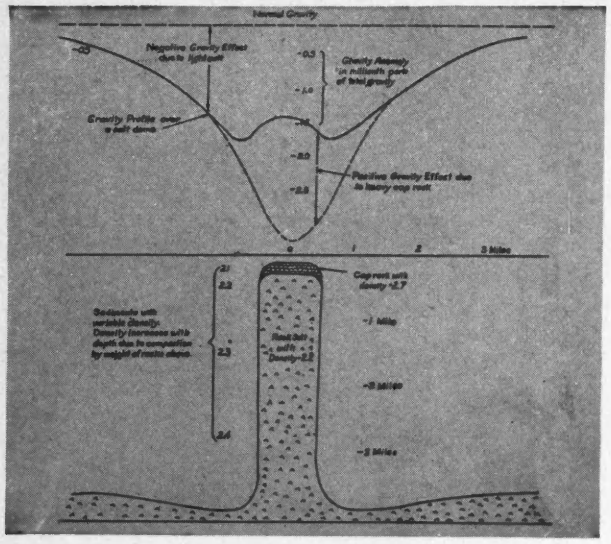

Normal Gravity
Negative Gravity Effect due to light salt
Gravity Anomaly in millionth parts of total gravity
Gravity Profile over a salt dome
Positive Gravity Effect due to heavy cap rock
0
1
2
3 Miles
Sediments with variable density. Density increases with depth due to compaction by weight of rocks above
Cap rock with density +2.7
Rock salt with density 2.2
1 Mile
2 Miles
3 Miles

Fig. 4. Gravity profile and cross section of salt dome.

work employed the refraction seismograph method and particularly the mode of operation known as "fan shooting." A charge of dynamite is buried, and the time required for waves set up by the explosion to reach detectors at distances from five to ten miles is accurately measured. The detector positions are usually at approximately the same distance from the shot point but in different directions; hence the term "fan." The speed of these waves in salt is about 16,000 feet per second, while in the surrounding sediments it is variable and increases with depth but is always much less than in salt. Thus, if part of the path followed by a wave is through salt, it reaches the detector sooner than it would if the path were entirely through the normal sediments. If the wave reaches a particular detector at a time shorter than normal, it may indicate a dome somewhere along that particular ray of the fan. To locate the dome more closely, a cross-fan is usually shot with lines crossing the rays of the first fan which show the greatest time lead or speeding up of the time of travel. The intersection of lines showing the greatest lead indicates the approximate position of the center of the dome. Time leads due to domes vary from a few hundredths of a second up to nearly one second, depending on the size and depth of the dome, the distance between shot and detector, and their positions relative to the dome. Fig. 5 shows a fan shooting plan, the time leads, and a rough outline of the dome indicated by these leads.

Another type of seismograph exploration is used to detect disturbances produced by the domes rather than the domes themselves. This is the so-called reflection seismograph method. A relatively small charge of dynamite is exploded at the surface, and a series of detectors is set up within a few hundred feet of the shot. The detectors are electrical and are connected through suitable filters and amplifiers to a multiple oscillograph. The ground movements resulting from the explosion are recorded simultaneously and side by side on a single strip of photographic paper. These tapes show, first, relatively strong ground movements due to the disturbances which travel along the surface of the ground from the shot to the detector. Further along on the tapes (corresponding to later times) the surface disturbances die out and other disturbances appear on the record. These later disturbances are due to waves which are reflected back from some discontinuity in the rocks, as shown in Fig. 6. The depth to the reflecting "horizon" can be calculated from the time of arrival of the reflection on the record and from the average velocity which is known from other records especially made for that purpose. By properly correlating and recognizing the records from the same horizon at different shot points it is possible to make a sub-surface contour map of that horizon and to detect the arching or uplift of the overlying rocks which may be caused by a salt dome below them.

There is of course no direct physical or chemical relation between salt and petroleum. The commercial production of oil in general must come from an area where millions of years ago conditions were favorable for luxuriant vegetation and abundant marine life, and where later great deformations of the earth's crust have occurred, forming uplifts, arching of the sandstone beds, or faults, which serve as traps to hold the oil accumlation. Nature in providing us with salt mountains has furnished in this restricted Gulf Coast area merely one of the many known processes whereby oil traps have been created and petroleum has been conserved for the benefit of humanity.

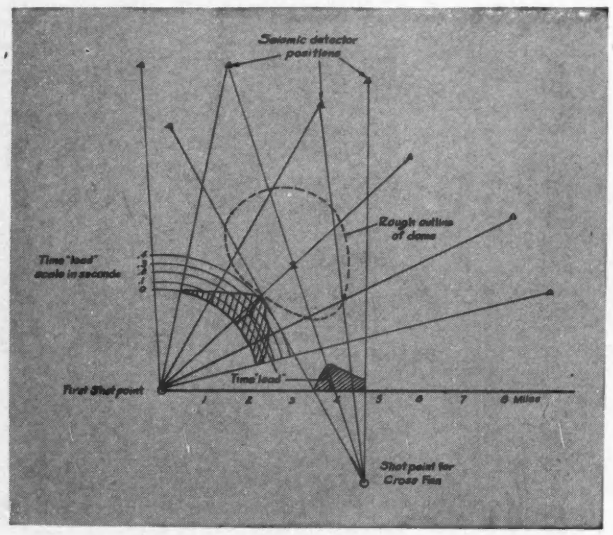

Seismic detector positions
Rough outline of dome
Time "lead" scale in seconds
First Shot point
Time "lead"
1 2 3 4 5 6 7 8 Miles
Shot point for Cross Fan

Fig. 5. Fan shooting to detect salt dome.

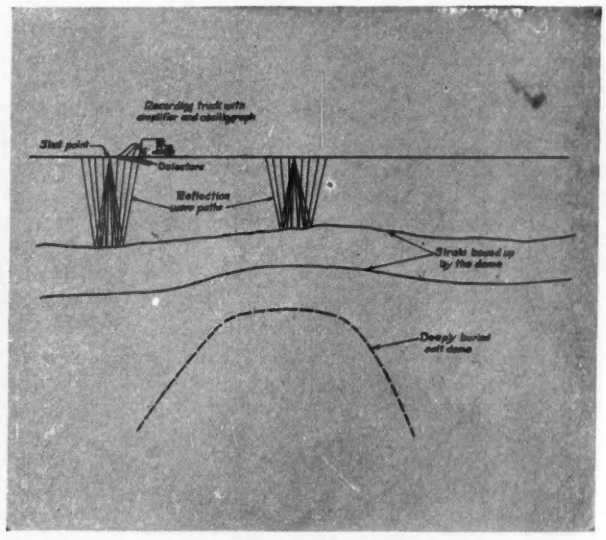


Fig. 6. Reflection shooting over a deep salt dome.

THE FORCE OF LANGUAGE

is as fundamental as f=ma

By ***FREDERICK G. FASSETT, JR.***
Assistant Professor of English

> *Strong Son of God, immortal Love,*
> *Whom we, that have not seen thy face,*
> *By faith, and faith alone, embrace,*
> *Believing where we cannot prove;*
>
> *Thine are these orbs of light and shade;*
> *Thou madest life in man and brute;*
> *Thou madest Death; and, lo thy foot*
> *Is on the skull which thou hast made.*
>
> *Thou wilt not leave us in the dust:*
> *Thou madest man, he knows not why;*
> *He thinks he was not made to die;*
> *And thou hast made him; thou are just.*
>
> —"*In Memoriam*," by Alfred Tennyson.

LANGUAGE as the expression of thought may be regarded in two ways. Usually, it is considered an artistic medium, comparable to the painter's colors and the sculptor's marble, through which an aesthetic impulse is given form and significance. This view of language comes first into the mind of the civilized man largely because of the great age of the literary tradition—the employment of language in the creation of forms with a primarily aesthetic or recreational purpose, —and because of the comparatively short period of the applied as distinct from the artistic use of language. The second conception of language, as it had to grow out of this applied use, has had to wait for that use to become general and to bulk nearly as large in actual productions as the artistic use. Only when material advances had gone far enough to bring home to every man, however little, the importance of specific and concrete facts in contradistinction to general and speculative ideas, did the second view gain prominence. Language, according to it, is a practical means through which a plastic mass of thought or fact is given rational form and consequent utility.

The intrinsic difference between the two forms of expression is illustrated in the work of the poet Vergil and that of the geographer Strabo. The first is literature; the second is not. The relative place traditionally given the two is to be seen in the fact that in our studies Strabo has occupied second place to Vergil, both quantitatively and qualitatively. Thus also is explained the usual priority of the literary view of language, a priority which still holds, but which is perhaps not as pronounced now as it was even fifty years ago.

Useful as they may be, however, these two interpretations of language are each at least once removed from the actuality. Whether regarded as an artistic medium or a practical means, language is a force. The argument which holds that language is only the carrier of a force, and that the force itself is the idea, may be met by comparing them to a carrier frequency and a modulating frequency. When language, the carrier, has been modulated by thought, the resulting expression is comparable to a modulated carrier frequency. The two components are virtually inextricable. The demodulator is of course the mind of the receptor; the peculiar difficulty of the task of writing grows principally out of the fact that the condition of this demodulator is beyond the control of the writer, and yet may be so poor as to garble the message hopelessly.

The force does have the two distinct phases which have been mentioned, the aesthetic or artistic, and the practical or applied. The first is essentially an emotional force directed toward an emotional end; the second a rational or intellectual force directed toward a rational or intellectual end. That is, a qualitative change takes place in language according to the end for which it is used. The nature of this change will later appear. How real and yet how subtle is the difference between the two phases may be surmised by comparing a chapter of *On the Origin of Species* with a poem by Tennyson, perhaps a unit from *In Memoriam*. To consider further the two forms and trace their delicate intermingling in different kinds of writing, ranging from the purely aesthetic in a lyric to the purely practical in a set of specifications, with all sorts of blendings between in novels, essays, plays, is an undertaking unfortunately too extensive for this discussion.

(Continued on page 96)

> *The view commonly entertained by naturalists is that species, when intercrossed, have been specially endowed with sterility, in order to prevent their confusion. This view certainly seems at first highly probable, for species living together could hardly have been kept distinct had they been capable of freely crossing. The subject is in many ways important for us, more especially as the sterility of the species when first crossed, and that of their hybrid offspring, cannot have been acquired, as I shall show, by the preservation of successive profitable degrees of sterility. It is an incidental result of differences in the reproductive systems of the parent-species.*
>
> *In treating this subject, two classes of facts, to a large extent fundamentally different, have generally been confounded; namely, the sterility of species when first crossed, and the sterility of the hybrids produced from them.*
>
> —"*The Origin of Species*," by Charles Darwin.

TROPICAL MEGAWATTS

—*Electricity in the Jungle*

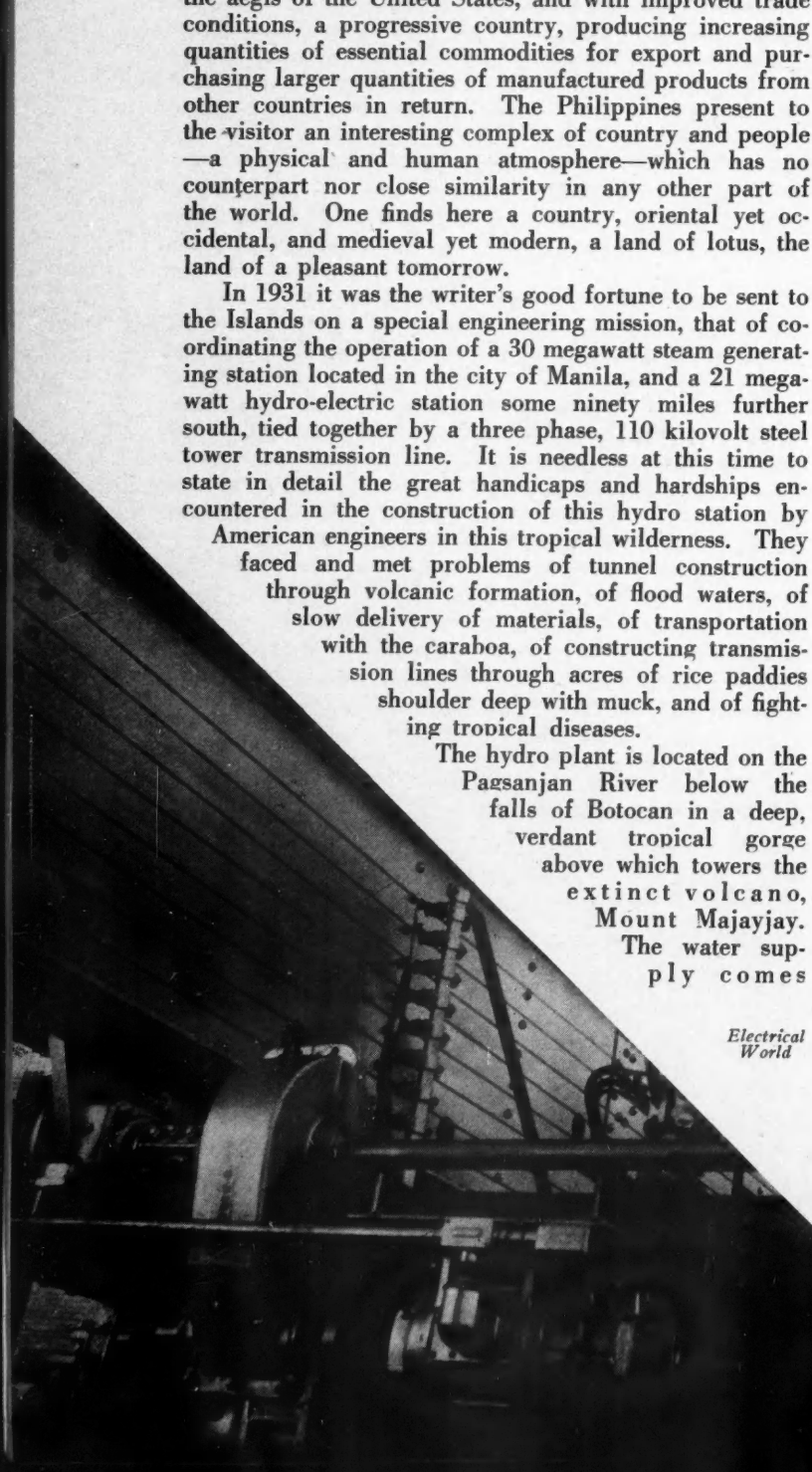
By A. P. BROADHEAD
Director of Dispatchers Institute

NEAR the southeast door of the great continent of Asia, equi-distant east and west of New York, and in the latitude of Panama and Central America, is located a group of richly favored islands, namely, the Philippines, which are the United States' tropical outpost in the Orient. When New England is wrapped in the darkness of midnight, perhaps under a mantle of snow and ice, the Philippines are basking in the warmth of the noonday sun twelve hours ahead of New York in time, though some forty odd days distant from the Atlantic seaboard by steamer.

Obscured for centuries in the shadow of mystery and innate backwardness, the Philippines are today under the aegis of the United States, and with improved trade conditions, a progressive country, producing increasing quantities of essential commodities for export and purchasing larger quantities of manufactured products from other countries in return. The Philippines present to the visitor an interesting complex of country and people —a physical and human atmosphere—which has no counterpart nor close similarity in any other part of the world. One finds here a country, oriental yet occidental, and medieval yet modern, a land of lotus, the land of a pleasant tomorrow.

In 1931 it was the writer's good fortune to be sent to the Islands on a special engineering mission, that of coordinating the operation of a 30 megawatt steam generating station located in the city of Manila, and a 21 megawatt hydro-electric station some ninety miles further south, tied together by a three phase, 110 kilovolt steel tower transmission line. It is needless at this time to state in detail the great handicaps and hardships encountered in the construction of this hydro station by American engineers in this tropical wilderness. They faced and met problems of tunnel construction through volcanic formation, of flood waters, of slow delivery of materials, of transportation with the caraboa, of constructing transmission lines through acres of rice paddies shoulder deep with muck, and of fighting tropical diseases.

The hydro plant is located on the Pagsanjan River below the falls of Botocan in a deep, verdant tropical gorge above which towers the extinct volcano, Mount Majayjay. The water supply comes from a concrete dam about a mile above the falls, through a tunnel where it emerges into two steel penstocks which take a 500 foot drop almost perpendicularly down the gorge sides to the turbines below; this furnishes a 650 foot head, at a pressure of 250 pounds per square inch, on the turbines in the station. Once in the plant the engineering mind forgets the tropical surroundings and is fascinated by the vertical generators, the methods of ventilating these generators by ducts and huge exhaust fans, the extreme height of the station inside to give adequate air space, the intense noise of rushing water through the reaction type turbines, the KVA load and power factor and the steady frequency, the high apparent temperature of the Kingsbury and guide bearings, the coil temperature, and by the operating mechanism of the butterfly valves and governors. Also of interest are the protective relays which guard against overspeed, overload, overheating, loss of exciter voltage, low air pressure, and overheated bearings. The direct connected exciters and their exciters located on top of the alternators, the water level indicators (head and tail water), the remote control switches (oil and gang operated; disconnect and horn gap switches), the water filtration plant for filtering the process water, the storage battery for auxiliary and emergency lighting and for operating the remote control switches; each lends its enchantment to the engineer and helps maintain service.



Electrical World

As you wend your way toward Manila through miles of cocoanut palm groves that shelter the ever present monkey, now and then a cocoanut is hurled at you from among the palm leaves—a huge lizard flounders across the trail just ahead of your car, or you see a twenty-foot python "ooze" off the road into the entanglement, visible only by the swaying jungle growth.

The Botocan plant is situated at an elevation of 1800 feet above sea level, the consequent descent to sea level at Manila is picturesque, and when the lowlands are reached hot springs and salt springs are found along Laguna De Bai, not mentioning the numerous barios or villages with the native folk and their quaint ways and fantastic costumes.

The Manila steam plant is located on the Pasig River, a muddy tropical stream, which flows through the city, the outlet of Laguna De Bai and supplies what has to be considered as cooling water for the condensers. During the dry season the temperature of the condenser water from the river averages 85 deg. Fahrenheit, and of course has effect on vacuum of the turbines.

The enormous amount of riff-raff in a tropical river is astounding. Huge "islands" of tropical growth float down and against the intake racks of the condenser pumps, thousands of so-called "sardines" pass through the trash racks and pumps, and plug the condenser tubes. The river is green for weeks from the Algae which is held in suspension in the water. Aside from these factors condensing is perfect.

A boiler room in the tropics is a revelation to the combustion engineer of the North Temperate Zone. The boiler "room" is not a room but merely adequate roof-

ing and siding down to about 15 feet from the ground to protect the boiler setting from rain.

The equipment is similar to any modern boiler plant —automatic stokers, coal and ash handling—total load indicator, calorimeters, economizers, boiler feed pumps, draft gages, etc.

The fuel consists of Fushun coal containing the average B. T. U. and a free ash. Great care is required in the storage pile on account of the constant high air temperatures.

The turbine room is characteristic of the rooms in the tropics — high and well ventilated.

All foundations are large and deep set to withstand earthquakes which are prevalent, particularly during the rainy season.

The operating problems are many and varied. The requirements of the system are between ninety and one hundred twenty million K.W.H. per year. A study has to be made of the combined operation of the hydro and the steam plant.

During periods of minimum stream flow the most attention was necessary in order to attain maximum combined efficiency. Particular attention is paid to the operation of the hydro turbines on light load on account of the pitting of the runners, which operate at 750 R.P.M., new runners were kept in stock. The factory was 12,000 miles away. During the periods between maximum stream flow the portion of the system load carried by the hydro plant is correlated to the water available and the system load. It soon became easy to predict in advance the quantity of water, and hence the kilowatt hours, which are available for the ensuing day. Knowing the system load, maximum benefits are obtained from the hydro. At all times the steam plant is considered as an auxiliary to the hydro, and under certain conditions the efficiency of steam plant, considered by itself, is decreased due to the load carried on the hydro, but maximum combined system efficiency is the end sought at all times.

The days and nights in the tropics are approximately twelve hours each, so that except during the rainy season the loads are more or less uniform. The difficulties encountered in educating the native operator for the position of load dispatcher took almost all the romance out of the expedition but success was finally achieved.

A very interesting feature in the system operation was the study of the typhoons and watching their course. Instruments for detecting the formation and movements of typhoons were perfected and produced by the Spanish Monks who operated the Philippine weather bureau. These instruments plus the aid of the ordinary aneroid barometer, and weather-vane permitted the dispatcher to forecast the direction of the formation of the typhoon, the general direction of its movement, and the approximate distance of the typhoon from the observer.

These typhoons are known by numbers, graded as to their intensity, from number one to number seven. In brief, number six will pass within five miles of the observer while number seven is beyond description as far as severity is concerned.

Signal boxes are located in conspicuous places in the city indicating by means of light behind the number of the typhoon expected—radio warnings are sent out to all shipping and the warnings are strictly adhered to. The wind velocity reaches as high as 100 miles

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Electrical World

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EDITORIALS

ECONOMICS FOR THE ENGINEER

THE five year course introduced this year, which affords an opportunity for students to engage in social studies along with other scientific or engineering work, is designed to fill a gap in the educational program of the Institute. The fact is supported by the experience of our graduates that an engineer is constantly confronted by problems of a business or economic character involving a different background of knowledge and a different technique of thinking than are likely to be developed in many of our professional courses. But apart from the professional value of this new plan there is the contribution it is calculated to make both to the individual student and to the nation. Scientific and technological progress is transforming the character of industry, is making new demands on government, the courts and other social institutions; and it is fitting that Technology should contribute its quota to the leaders who will assist in making the difficult adjustments involved in these changes. The value from a personal or cultural standpoint of being able to appreciate social values, to understand economic processes and to approach intelligently the great political and other social problems of this dynamic age can hardly be over-estimated.

The five year plan leaves the professional courses virtually unchanged. Beginning in the third year there is introduced a series of subjects chosen from the field of social science, and since the number of such subjects is not considerable until the fifth year, it is possible to make the necessary curriculum changes so that a person who embarks on the five year course is not irretrievably committed to it. Already a beginning has been made with the enrollment of a group of third year students, and the many graduates and others who have greeted the innovation with hearty approval will watch its delevopment with keen interest. It is a forward moving step and will help not only to enrich the educational experience of the student, but also to give the engineering profession that power in business and government which its scientific character entitles it to assume.

RALPH E. FREEMAN,
Professor of Economics.

TO THE CLASS OF 1938

With the first rush of getting into the swing of Institute life over, the Class of 1938 now has time to take a deep breath and look around for an activity in which to participate. The *Tech Engineering News* offers to the competitors for a position on the staff of the magazine an unusual field. Whatever your interest may be, there is a place for you on the T.E.N.—editorial, art, publicity, advertising, circulation, and treasury.

ENGINEERING DIGEST

HIGH PRESSURE MERCURY LAMP

THE development of the mercury lamp has been successfully accomplished and it has opened a new field of lighting. Designed to operate at a fixed voltage of 155, the lamps are no longer a laboratory product only; they are standard make lamp bulbs.

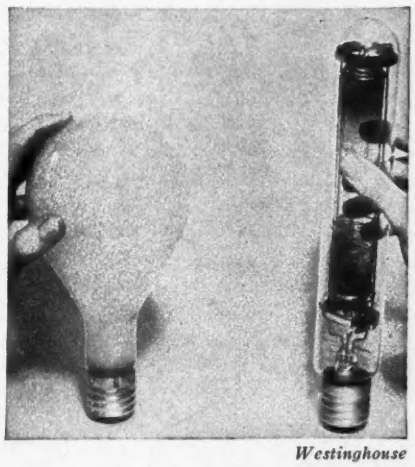
The lamp consists of an outer, protecting, glass shell which contains an inner glass tube in which are the electrodes and globule of mercury. This inner tube is made of a special, hard glass originally designed for use in retort tubes in the analyzing of certain carbon compounds. It is capable of withstanding high temperatures which fits it for use in the mercury lamp; approximately 1000 F. is the limiting temperature of this glass, over which, it becomes soft.

The construction of this inner shell consists of a tube or cylinder of this hard glass with caps of uranium glass welded to its ends in order to completely seal the leads to the electrodes. This welding was a very critical process to carry out successfully and a great deal of difficulty was encountered in the development of the proper method. The final result is a perfect joint, strong and absolutely air-tight.

Before the completed tube is sealed it must be thoroughly cleaned in order to eject all impurities which might affect the color of the emitted light and thus ruin the lamp. This cleaning is accomplished by filling the tube with certain rare gases and heating the electrodes to a high temperature. This heating drives out all impurities and when the gases are exhausted the impurities go with it.

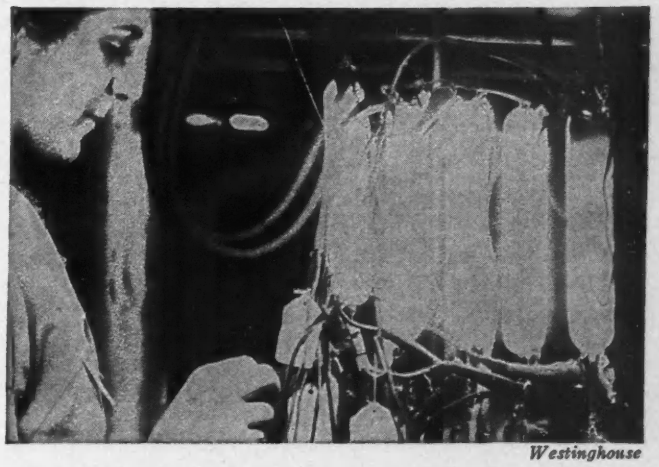
Having been thoroughly cleaned, the tube is filled with an exact, predetermined amount of mercury and sealed. The amount of mercury must be accurately determined since this factor dictates the voltage which will operate the lamp. The globule used to give operation on about 155 volts is about the size of a match head.

Installation is in an ordinary lamp bulb, thirteen inches long and two inches in diameter, the tube being held in place by special clamps. The resulting lamp is sturdy and practical for many purposes. (*Westinghouse Technical Press Service*)—R. Y. J.



Westinghouse

A standard 500 watt Mazda lamp and the new high pressure mercury lamp.



Westinghouse

To clean impurities out of the innertubes of the new high pressure mercury lamps, rare gases are injected into them and high temperature produced by heating the electrodes.

ELECTRONIC MACHINE GUN

THE time required for a fuse to open a circuit may be 1/5000 of a second or less. While searching for an adequate method of measuring the time-current blowing characteristics of instrument fuses, scientists have developed a set-up that will splatter "electronic bullets" on a screen at a tremendous rate so that an ordinary camera can be used to record the oscillogram which will show the duration of a fuse blow-out.

The complicated circuit provides for the release of electronic impulses generated through rotating gear teeth. A mechanical analogy is that of a machine gun firing between the blades of an aeroplane propellor. In this case a large gear is rotated by a high speed synchronous motor. As each gear tooth passes in front of a polarized electromagnet (placed close to the gear), an impulse is created which can be amplified by a screen-grid tube. In this way 5000 impulses per second are produced and shot onto the fluorescent screen (or grid) of a cathode-ray tube.

The electron velocities when they hit the cathode screen reach several thousand miles per second depending on the grid potential. During half of each impulse from the timing circuit the electrode beam of the cathode-ray tube is completely shut off, but when uninterrupted by a gear tooth the full beam shoots on the screen. This succession of shots is spread in a line over the screen by means of a non-recurring sweep circuit.

In recording a transient (such as blowing a fuse) the potential drop across a resistor starts the fuse blowing and the sweep circuit moving simultaneously. The brilliant point was recorded by the beam shooting at rest. A small leakage in the circuit draws the beam down slowly before the relay contacts are closed. At this point the beam shoots rapidly returning to normal almost instantaneously. It was found that the time required for a fuse to open a circuit drops rapidly as amperage is decreased. Some interesting patterns of recurring phenomena have been obtained. (*Radio Engineering*, vol. 14, no. 2, June, 1934.)—J. K. J.

RESEARCH IN REVIEW

COURSE III — Mining and Metallurgy

THE recent addition of Ceramics and Electrochemistry to the department has increased the number and variety of research problems. Several of the general projects which have been in progress for a long time are continuing. The subject of hardening by nitrogen instead of carbon (nitriding) is being studied with special reference to its application to cast and to malleable iron. Work in the nitriding of steel continues largely with the view of producing nitridable steels other than those regularly used. In the laboratories of X-ray Metallography three general classes of problems are being studied: (1) An investigation by X-ray methods of a number of alloy systems for the purpose of determining the mechanism of age or precipitation hardening,—a question of great theoretical as well as practical importance; (2) The application of X-ray methods to the study of internal stresses in metals and (3) Radiographic studies of castings and welded joints are being continued.

Important researches in the field of the Physics of Metallography are in progress along two general lines: (1) The development of methods for describing quantitatively the physical structure of metals to supplement the information now obtained by X-ray methods. Magnetic, elastic and electrical properties which vary with grain orientation and internal strain will be studied to determine the fiber structure of metals and alloys during various stages of their production. (2) An investigation of the magnetic structure of ferromagnetic crystals. In the division of Ceramics four major investigations are in progress: (1) Studies of the plasticity of clays and finely ground minerals with a new high speed stress-strain recorder. (2) A study of the lead-silver glasses using X-ray diffraction methods and viscosity measurements. (3) High temperature fusion point determinations are being made in a molybdenum vacuum furnace. (4) The formation of clay from feldspar in a high pressure bomb is under investigation.

COURSE VIII — Physics

THE past summer saw much activity in the Institute's Spectroscopy Laboratory, where a number of visiting scientists from the United States and abroad worked from two to ten weeks on problems which could be advanced by use of the Institute's spectroscopic equipment. Over a hundred and thirty biologists, chemists, metallurgists, physicists, and medical research workers gathered for the greater part of a week in July to attend the Institute's second Spectroscopy Conference and to discuss the uses of spectroscopic methods in their respective fields.

Most of the problems being attacked by Professors Harrison, Boyce, and Wulff, Institute spectroscopists, have to do with the structure of atoms and molecules as interpreted by means of the spectroscope. However, several projects have recently been undertaken which involve co-operative ventures with members of other departments. One of these, which the Rockefeller Foundation has recently undertaken to support is a spectroscopic investigation of the metallic constituents of the blood, to be undertaken by Professor Harrison in collaboration with members of the staff of the Children's Hospital of Boston.

Considerable progress has been made in the Spectroscopy Laboratory in the development of automatic machinery to assist in the laborious work of measuring the wavelengths of spectrum lines and interpreting the results in terms of atomic structure. One machine now practically completed has already reduced the labor of measuring spectrum plates by 80 per cent., and is expected shortly to reach a stage of development where it will do in a few minutes what formerly required many hours, with a threefold increase in accuracy.

In the X-ray Laboratory Professor Warren and Dr. Gingrich have been obtaining important results on the correlation of crystal structure and physical properties. Much work has been done on the structure of various glasses and liquids. The crystalline modifications of sulphur and the structures of the sulphur melt have also yielded interesting results.

Work is still progressing on the large high voltage generator at Round Hill, where Professor Van de Graaff and his associates expect to have the generator in action bombarding the nuclei of atoms very shortly. Recent developments there have been concerned with the construction of the giant vacuum tube which is necessary to make efficient use of the tremendous voltages available by the generator.

COURSE X — Chemical Engineering

A number of research projects started last year by various members of the Chemical Engineering staff and by graduate students were continued through the summer in the department laboratories. The topics studied covered a varied field, but in almost every case the individual problem represented one phase of a larger research program.

Mr. A. C. Burr completed a study of the relation between the volumetric efficiency of a high vacuum pump and the pressure at which the pump is operated. For this study a special welded tank of approximately 200 cu. ft. capacity was installed in the pit of the large laboratory. The volumetric efficiencies were calculated from the data obtained in pumping out this tank.

Progress was made in the construction and testing of an improved apparatus for continuing the department's research on the mechanism of filtration. Filtration is one of the important unit operations of Chemical Engineering, the principles of which have been a subject of study by the Chemical Engineering Department for many years.

The design of distillation equipment requires a knowledge of both plate efficiencies and limiting vapor velocities in the standard types of equipment. Plate efficiency, which determines the required height of the equipment, has been the subject of study by the department for some time. Recently the project has been started of collecting the necessary data on allowable vapor velocities, in order that it might be possible to predict the capacity of distillation equipment above which an excessive amount of liquid is carried up the column from one plate to another.

THE RUST RACKET

(Continued from page 85)

ing in a big way. And it was a pronounced success.

Within a few months' time, not only radiator and lamp shells were being made of "Rustless Steel," but in addition, other parts such as hub caps, cowl mouldings, windshield stanchions, running board strips, hood hinges, gasoline tanks, radiator caps, and wire, disc and artillery type wheels. Truly, it can be said that the "Era of Stainless Iron" began with the advent of its use on this popular priced motor car. Since that time other motor car manufacturers have adopted stainless for a number of items just listed, as well as for water pumps, shafting, butterfly valves, and exhaust valves.

Several types of stainless iron are employed for automotive parts, the most common type being that containing approximately 17 per cent. chromium. The 18 per cent. chromium—8 per cent. nickel type, commonly known as 18-8—is used only for parts involving difficult forming problems, such as especially deep drawing and stamping work as exemplified by lamp shells.

Uncle Sam has realized the merits of the non-rusting steels and is taking advantage of their properties to the utmost. The U. S. Navy Department is probably the leader among the various government agencies in the adoption of stainless iron, and justly so, for the Navy Department is deeply concerned with salt air and salt water corrosion. It has been reported that several thousand tons of corrosion resisting alloys will be employed in the construction of the new navy vessels. Because no allowance in thickness need be made for corrosion losses, and further, because stainless has twice the strength of ordinary steel, the result will be lighter weight ships, providing for more guns under a given tonnage. For just what purposes the stainless iron will be used, it has not been disclosed, but it can be assured that the embodiment of stainless will result in better ships and will materially reduce maintenance costs of the fleet. No doubt the navy gobs, who spend a great deal of their time polishing brass and other metal equipment aboard ships, will give a loud cheer for stainless iron. And before passing, mention should be made of the very capable navy engineers who have been responsible for the wide use of stainless in this branch of the government.

The aeronautic branch of the navy has not been outdone by its sister department, and they, too, are specifying corrosion resisting alloys profusely, for such parts as exhaust manifolds, fittings, stream line tie rods, pontoons, and floats. The day is, perhaps, not far distant when the entire ship will be built from sheets of high strength, non-corrodible stainless iron. England already has found this type of aircraft to be structurally and mechanically sound.

The various War Department offices about the country, that are in charge of the designing and engineering in connection with the Mississippi and Ohio River lock and dam projects, are calling for generous amounts of corrosion resisting alloys to be used at points where rust and corrosion can cause trouble. The initial cost of such projects, wherein stainless irons are used, is perhaps, considerably higher than where ordinary steel is employed; but again, successful operation of the locks depend upon the elimination of rust and corrosion, which can only be assured with stainless alloys. Costs of operation, however, are low, maintenance costs are practically negligible, and in a matter of a few years, the extra cost of stainless will be more than recompensed for by the resultant savings; savings not only to the government, but even better, to the public in the form of lower taxes. In other words the "Rust Racket" is taking one on the chin.

Foreign nations have seen the wise economy of the use of stainless iron. A recent power transmission project in India employed over two thousands tons of stainless plates, sheets, and tubes. The term "Rust Racket" would not be understood by the natives of India, but they have realized the necessity of combating the ravages of rust and their answer to the challenge was "Stainless Iron."

The stainless irons and steels are really a foreign discovery, Harry Brearley of England having obtained a patent on a stainless steel containing about 12 per cent. chromium in 1914. This alloy could be hardened and has been applied mostly to cutlery ware. About the same time in Germany, Dr. Benno Strauss, of Krupp works, discovered the stainless properties of the 18 per cent. chromium, 8 per cent. nickel alloy which was a non-hardening iron. Since that time, there have been numerous other patents granted here and abroad, which are modifications of the two fundamental types of which reference is made. It would be natural to assume that England and Germany, being founders of the stainless alloys, would lead the world in their development. This, however, does not seem to be the case, and as is so often true, America has taken the play away from them.

An amusing incident is told of a large foreign steel concern which owned a patent on the processing of stainless steels. Several steel producers in this country were licensed under this patent, and in order that the licensees might derive the full benefits accruing from the patent, representatives were sent here from abroad to assist in the successful application of the sailent points outlined. Their word was taken as the gospel truth and their instructions followed as religiously as possible. Perhaps on a small scale their methods would have been success-

(Continued on page 99)

Don't get low in Spirits!

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THE FORCE OF LANGUAGE

(Continued from page 89)

Debated though its application to some forms of energy may be, the quantum theory is inescapably true for the force known as language. This very definitely is not a continuous wave, but is a series of quanta, even though these may not be identical in size, and may not be infinitesimal according to many scales. Relative to the whole force existing in language, however, the quanta—words—are in themselves minute. Yet though relatively minute, each, as we shall see, can by a process of interpenetration evoke nearly the whole total force.

These quanta of language may be divided into three groups, all of which are in a sense positive; one of these is static, the second is dynamic, and the third seems to have both static and dynamic nature, paradoxical though that may seem. The first group consists of nouns, the names of things and ideas; the second, of verbs, the names of what is done by and to things and ideas; the third, of connective and transitional words and expressions, which serve to link nouns and verbs in coherent systems. Those words which grammatically are known as adjectives and adverbs are in this scheme but properties of static and dynamic quanta respectively.

Difference in the arrangement of these quanta is the characteristic marking the two phases of language which have been discussed—the emotional and the applied. The first can be considered the result of a cumulative arrangement of quanta, an arrangement producing an excitement in the receiving mind which builds up stage by stage as the quanta are received, until a full load has been transmitted and a point of discharge, or emotional release, has been reached. The intellectual phase, on the other hand, seems to be the result of a patterning of quanta, their despatch to the receiver in measured groups which put the receiver in a state that does not terminate in the flash-over of emotional discharge, but continues in steady activity.

For the total force of language, or for the units in the first two groups of quanta, the equation holds true:

$$F = \Sigma MA$$

where M is the meaning or significance of the individual word as recorded in dictionaries, and A is its applications, adaptations, or connotations—the subsidiary meanings which each word is given because of its association with other ideas in the mind of the receiver. An analogy may be drawn between these applications and the overtones of a musical note.

The element A, given this meaning, is one of the most variable variables yet devised, and hence the equation must be regarded as used here for convenience and point, rather than with a view to immediate practicability. Here A varies relative to time, place, age of the

(Continued on page 98)

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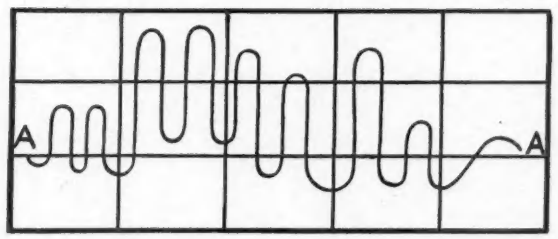

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The Force of Language

(Continued from page 96)

word in question, every experience and every recollection of the receiver, other words surrounding the word in question, and so on, more and more. When the connotations which a given word sets up in the mind of a reader are unfavorable to the purpose for which the word was used, we may say that *A* is negative. When the connotations add to the effectiveness of the word, and *A* is positive, it produces the interpenetration mentioned before, as a result of which one quantum can evoke the total force. For example, the quantum *words*, when *A* is positive, calls up *speech*, *writing*, *dictionary*, and hence all the words in the dictionary, if the process be continued long enough.

In prose employing the second phase of language, prose which has an intellectual object, and hence relies for its effectiveness upon a patterning of quanta, the element *A* applies fully as much to customary patterns as to individual words. For instance, to open a scientific abstract with the words, *I take my pen in hand*, is to set up overtones of pre-machine days which may utterly defeat the purpose of the writing. *A* here is negative. Similarly, to close a business letter with the stereotyped, *Hoping to hear from you soon, I remain*, reduces *A* to zero, and thus cancels *F*.

Quanta of the third group, the connectives, are of distinct importance, since they provide the hook-up by means of which the force of language functions, and faulty connections easily mean futility. For them, $F = M$ only. To use *thus* for *therefore*, or *and* for *or*, as anyone knows, radically alters the meaning of a sentence. And the trouble can easily extend beyond individual words, for example in the sentence, *The foreman continually bawled at the men in abusive language; in this way the crew called a strike.* The author of that sentence did not mean to call up in his readers' minds the picture of an aggrieved crew bawling at each other in abusive language that the time had come to strike. But that is what his sentence does. Substitution of, *as a result*, in the proper place makes the difference.

These last illustrations are of course trivial in themselves, and it must be admitted that much of the convention surrounding language appears trivial at times. But in a very large sense it is true that man's mastery of other forces such as those associated with electricity or with heat as employed in steam has depended in the first instance upon his control of the far more mysterious force of thought or idea which as we have seen cannot be dissociated from the force of language. His direction of the physically more perceptible electricity and heat toward social ends has in large measure meant civilization as we know it. Exertion of the force of language has been and remains his sole means of increasing the consciousness of social responsibilities upon which depends the contiuuation, not to say the very life, of that civilization. Regarded in this light, the often perfunctory business of fashioning a purely utilitarian sentence takes on profound significance.

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The Rust Racket

(Continued from page 95)

ful, but not so in the manner the United States is accustomed to doing things. Consequently, shortly after their departure, their instructions were quickly forgotten, and methods more suited to American practice were evolved, which resulted in lower costs and a product much superior to that manufactured by the foreign country. A year or so later, under the guise of giving America further help, the same delegation returned to learn for themselves what was being done in this country to produce a product so much superior to their own.

The revival of building, if and when, will see the rustless metals used for a great number of purposes. Architects have had little to do since 1930, and when they do become active again they will welcome the opportunity of designing smart outstanding structures, the features of which will embody the use of stainless and rustless metals. The little building that has taken place in the past three or four years has seen the use of considerable stainless steel. The Empire State building, with its gleaming runners of 18-8 stainless iron, extending from the 6th floor set-back to the top, is a familiar sight to millions, as too, is the glistening spire of the Chrysler building in New York City, entirely sheathed in bright polished metal of the same analysis.

For the private home, the stainless steel kitchen sink is available, and a good many housewives are already familiar with the merits of stainless steel cutlery and cooking utensils. On exhibit at "A Century of Progress" was an all steel house, trimmed with stainless steel, which enhanced greatly its appearance. Polished kitchen stove pipe lends atmosphere to the modern kitchen, and a furnace smoke pipe of the same metal lends years and years of extra service to this department of the house. Spoutings, flashings, gutters, piping and hot water heaters will be built into the homes of the future.

It is surprising to learn of the many and somewhat uncommon applications to which stainless iron is sometimes put. A large penitentiary has placed in each cell a highly polished mirror of stainless steel. The reflectivity is nearly as good as that of a silvered plate glass mirror, and it cannot be used to cut one's throat. Another prison serves meals in stainless steel dinner plates. There is no breakage of dinner ware when the inmates of this institution go on a sudden rampage and pound the tables with their plates, as prisoners sometimes do. In the first-class hospitals all the kitchen equipment is of this everlasting metal—even to the dishwasher. For operating room and surgical equipment, stainless iron again predominates. It is of particular importance for such items because of its non-staining properties and the ease with which it can be sterilized.

Industry has taken stainless steel to its heart, not because it has any particular warmth for it, but because it has paid its way. Large chemical plants have discovered that equipment made from stainless steel lasts longer, and that the resultant product of manufacture is of high purity and quality, uncontaminated with rust or the products of corrosion. Paper mills, textile and dyeing plants, food and meat packing plants, breweries and soft drink concerns, all are users and boosters of stainless steel as an available means of putting to rout the "Rust Racket."

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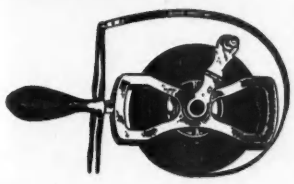

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Tropical Megawatts

(Continued from page 91)

per hour. These typhoons usually originate in the Pacific about southeast by south of Philippine Islands and generally take a north by northwest course.

Two weeks prior to the advent of a typhoon the weather becomes unsettled and earth tremors are frequent, accompanied by excessive rains.

The average annual rainfall in Manila is approximately 72 inches. The writer saw three inches of rain fall during a period of 27 minutes, and for the season of 1931 the total rainfall amounted to 108 inches. Imagine what would happen if this amount of rain should fall in a country whose normal annual rainfall is 30 inches.

The advent of the typhoon or rainy season is heralded by the migration of insects of every description into the homes, rich and poor alike.

Precautions are taken, the legs of tables stand in metal cups containing oil or water to prevent the insects from running around on top of the tables. One specie of ant flies—they have to be "swatted."

The Philippine archipelago consists of some 1200 islands—isles of romance. Jolo and the Sulu Seas, Zamboanga and Mindanao, Cebu, Mactan, Dumaguete, and Iloilo. The very names are redolent with the tang of the sea.

They are reminiscent of the rustling of palm leaves in the soft sea breezes beneath the Southern Cross, of the golden crescents of gleaming sand, of fancy colored sails skimming over seas of sapphire. These names call up pictures of coral islands, palm fringed beaches, rolling hills covered with the never ending rows of stately cocoanut trees.

Transportation among them is via modern freighters equipped with fairly decent accommodations. From one's deck chair he sees to starboard pearl fishers rocking at anchor, trading schooners slip in and out of sequestered harbors; the Moro sea gipsies sailing the blood-red seas into the setting sun, native bancas slip by manned by dusky, husky south sea islanders—they raise their arms in salute, then prepare to ride the swells from your steamer.

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In A Jointless-Minded World

Welding would prevail—and old methods of joining could not be restored to favor.

By **E. A. DOYLE***

If welding had become the standard method of manufacture before mechanical types of joints were introduced, it would be difficult, indeed, to convince manufacturers that they should redesign their metal products to use mechanical methods of joining.

NO RETREAT—pipe line constructors would never consent to a change from simple, portable welding equipment to the complicated devices essential to other methods.

Welding Gives Strength

Strength would be a talking point for welding. The welded joint is strong as or stronger than the metal which it joins. The cutting of holes for screws or bolts would naturally weaken the structure. Appearance gives welding another vote. Joints made by welding are smooth in contour and have no depressions, bosses, projections or attachments as is often necessary in mechanical means of joining metals.

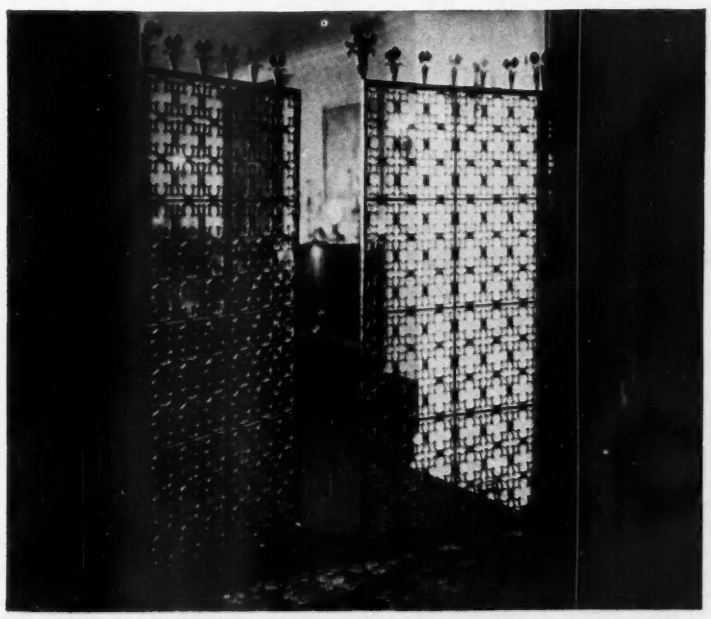
Costs Less to the User

Cost would be another argument for welded joints. The greater amount of material necessary with mechanical joints, the increased weight, and the decrease in pay load or performance-to-weight ratio, would make welding the preferred method. Nobody would consent to a joint in piping, which might, through a tiny leak cost much more than the permanently leakproof welded joint. Nor should it be necessary to buy expensive machinery to make mechanical joints which welding can equal in performance, economy and adaptability with a minimum investment in metal fabricating equipment.

Modernizes Automobile Design

Automobile manufacturers would insist on welding rather than consent to a return to the design limitations imposed by mechanical joints. In face of a change from "teardrop" designs to the old boxlike bodies, with the attendant discomforts, with higher cost due to increased gas consumption and increased tire wear, with the fear of accidents increased by the lack of confidence in the joints, with appearance impaired and lacking the smooth surface for fine paint and lacquer finishes,—the automobile manufacturer would hesitate long before any but welded joints would even get a hearing.

METAL FURNITURE—The welded joints in metal beds, chairs and other similar furniture assure a sturdy and rigid assembly.



BEAUTIFUL USEFULNESS—typified in this welded ornamental iron gateway. Every joint is strong, sound and was made inexpensively.

In the Future

Farsighted industrial executives can appreciate that a completely "welding-minded" industrial world is not far off. They should use in their own manufacturing operations as many of the advantages of welding as possible. The welding engineers of The Linde Air Products Company can advise how oxy-acetylene welding could best be used in your plant. This service is obtainable without cost or obligation by application to any of the sales offices of The Linde Air Products Company located at Atlanta, Baltimore, Birmingham, Boston, Buffalo, Butte, Chicago, Cleveland, Dallas, Denver, Detroit, El Paso, Houston, Indianapolis, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Phoenix, Pittsburgh, Portland, Ore., St. Louis, Salt Lake City, San Francisco, Seattle, Spokane, and Tulsa. Everything for oxy-acetylene welding and cutting—including Linde Oxygen, Prest-O-Lite Acetylene, Union Carbide and Oxweld Apparatus and Supplies—is available from Linde through plants and warehouse stocks, everywhere.

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*Chief Engineer, Development Section, The Linde Air Products Company, New York. Unit of Union Carbide and Carbon Corporation.

—This being a Business-News Advertisement.

G-E *Campus News*

STONE-THROWING ROMEOS

The engineers of the General Electric Company have been asked to solve some unusual problems, but never before have they had to work against Cupid. This is how it came about: Some of the swains who did their courting in parked cars along certain lighted roads in New England found that the lamps crimped their style. With simple but destructive logic they decided to extinguish the lamps with stones. Their aim was so good that repairmen of the utility which serviced the lights could hardly keep up with their depredations. Finally, G-E illuminating engineers were called in to design a fixture to foil the stone-throwing Romeos. These engineers produced a cast-aluminum guard, which looks very much like a baseball catcher's mask. It protects the lamp, and at the same time helps to concentrate light on the roadway.

HURRY! HURRY!

A flood had crippled three important electric motors in the refinery of a large oil company on the island of Aruba, 50 miles north of the coast of Venezuela. The plant had to be shut down until new coils could be installed. Losses caused by the shutdown ran into thousands of dollars a day. An order for the coils and word of the refinery's predicament reached General Electric in Schenectady, N. Y., on a Sunday morning. Work began immediately, and by dint of night shifts and a great concentration of efforts, the two-and-one-half-week job was completed in three days. The 808-pound shipment of coils, conveniently packed in small cartons, was flown in a chartered plane from Schenectady to the Newark airport, where it was transferred to an Eastern Air Lines plane bound for Miami. On Wednesday morning the cartons were transferred to a Pan-American Airways ship at Miami for the hop across the Caribbean to Kingston, Jamaica. From there, they were flown directly to Aruba in a specially chartered plane. They arrived Saturday morning, just six days after the order had been received by General Electric.

J. A. H. Torry, Union College, '11, and G. H. Magner, Acadia College, Nova Scotia, '09, of the International General Electric Company, Inc., made the arrangements for filling the order.

FAT SPARKS

The artificial lightning boys have beaten natural lightning in one regard, at any rate. Engineers in the General Electric high-voltage laboratory have produced discharges of a quarter of a million amperes, which is greater than the current of any direct lightning stroke yet recorded. This current is discharged at a pressure of 150,000 volts.

Just as natural lightning, with amperage almost as great, destroys that which it strikes, so does the laboratory discharge; and just as natural lightning is accompanied by thunder, the laboratory bolts have their ear-splitting crashes. A copper wire a tenth of an inch in diameter is completely vaporized. A similar piece of iron wire is "exploded," the remaining ends continuing white hot for several seconds. A section of reinforced concrete is broken into bits. The handle of a silver-plated ice cream spoon vanishes with a shower of sparks, leaving behind only the bowl discolored by the heat.

These engineers were the first to produce 10,000,000-volt artificial lightning discharges, and they are continuing their studies through these high-current discharges, in order to find better means of protecting electric distribution systems. K. B. McEachron, Ohio Northern, '13, Purdue, '20, M.S., is director of the laboratory, and associated with him in these tests are: W. L. Lloyd, Rennselaer Polytechnic Institute, '18; J. L. Thomason, U. of Idaho, '29; G. D. Harding, U. of Arizona, '29; and J. R. Sutherland, Yale, '29.

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